The Comparison of Lead Content of Soil and Plants in Urban and Rural Area

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Although lead naturally exists on Earth, lead concentrations in the environment have been increasing for several centuries due to human activities including mining and smelting of ores, the combustion of fossil fuels, and the dissemination of lead through industrial processes(Patterson 1971&1972). But the most significant release of lead into the global environment has been the use of lead as an antiknock additives in gasoline and that has caused the atmospheric concentration, long-range transport, and atmospheric deposition of lead to increase by several orders of magnitude during the past 70 years (Nriagu 1988; Chow and Johnstone 1965; Murozumi and Chow and Patterson 1969). While much of the lead emitted by automobiles is deposited in narrow corridors along roads and highways (Zimdahl and Skogerboe, 1977), high concentrations of lead are found in surface soils of even remote ecosystems as a result of atmospheric deposition (Wang and Benoit, 1996). Lead consumption as a gasoline additive peaked during 1970's in the united states (USBM 1966-1989). After the U.S. congress passed legislation restricting the sale of gasoline with alkyl-lead additives, the amount of lead consumed in gasoline has declined sharply, resulting in lower rates of atmospheric lead deposition. At the Hubbard Brook Experimental Forest (HBEF) in New Hampshire, the input of lead in precipitation has declined by 97% between 1976 and 1989 (Johnson 1995). However a decrease in the lead accumulation rate in soil was expected as a response to decreasing atmospheric lead, a decrease in the lead content was not expected due to the presumed strong retention of Pb by soil (Selim et al 1990). As one of the most persistent metals, lead was estimated to have a soil retention time from 150 to 5000 years (Fried land 1990).

Lead, one of the most important environmental pollutants, has limited availability for plant uptake due to complexation with organic matter and precipitation as carbonates, hydroxides and phosphates (Mcbride, 1994). They could get into plants through root systems, and unusual high concentration of heavy metal in plants usually has bad influence on plant growth. However in our ecosystem, there are lots of plants acting as lead accumulator (Nanda Kumar, et al. 1995). And sometimes even though there is extremely high concentrations of lead in the soil, the concentration in the plants could be extremely low. But there are also some species which has a linear relationship between the soil lead concentration and the lead concentration in themselves. So they could be used as an

indicator of the ecosystem health. And being at the bottom of many natural food chains, metal-accumulating plants are directly and indirectly responsible for a large proportion of the dietary uptake of lead by humans and animals (Pendias1989). There is increasing pubil concern about health effects resulting from pollution of lead. A wide range of metabolic disorders and neuropsychological deficits in children have been noted (NAS 1980; EPA 1986; Nriagu 1988).

Audubon Zoo is a big park in New Orleans urban area. It is right beside the St. Charles Street and Magazine Street, two of the busiest streets in New Orleans. Although United States discontinued the lead usage in gasoline many years ago, little is known about the long-term health risks to people who live and work around this areas and the animals in the zoo. Since public are very sensitive to lead pollution, it is very important to know the concentrations of these heavy metals in plants and soil around the area. And in our research, we also try to compare the lead contents of soil and plant in this area with a rural area in Mandeville (outskirt of New Orleans) with much less vehicular traffic.

METHODS AND MATERIALS

Various soil samples were picked up from Audubon Zoo, Magazine Street, St. Charles street, and rural area in Mandeville. Samples were dried in oven at 80^{o}C for three days and then weighed. The samples were shaken in a container with two small hard balls to powder separately. For X-ray Fluorescence (XRF) Analysis, 0.9$\pm$0.0050g powder of each sample and 4.0$\pm$0.0050g wax were weighed out and mixed. The mixtures were pushed into small hard dishes with two polish surfaces (under the pressure of 15 tons for 10 seconds). For Inductively Coupled Plasma (ICP) analysis, 0.5000g. or less of each dry sample was weighed out and put into PFA vessel. (Because there are not a lot of organic matters in soil samples and high pressure will not build up in the vessel during digestion, the PFA vessel could be used.) Three consecutive programs were run to digest the soil samples. For "oxidize" program, 7ml of Nitric acid was added and the solution was digested for 20 minutes. The vessel was allowed to cooled down. For "Shale" program, 9ml of HF, 1ml of HCL were added and the solution was digested for 20 minutes. The vessel was allowed cool down again. And finally 30ml of saturated boric acid solution was added to run "Boric" program. After the vessel was completely cooled, the digestion solution was diluted to 50ml with deionized water and transferred to new plastic bottles.

Various plant samples were picked up from Audubon Zoo, Magazine Street, St. Charles Street and rural area in Mandaville (outskirt of New Orleans). Samples were dried in oven at 80^{o}C for three days and then weighed. The samples were then ground to powder separately. For X-ray Fluorescence (XRF) Analysis, 0.3$\pm$0.0030g powder of each sample was weighed out and pushed into a small hard dish with two polish surfaces (under the pressure of 4 tons for 7 seconds). For Inductively Coupled Plasma (ICP) analysis, 0.5000g. or less of dry tissue of each sample was

weighed out into lined vessel and 10 ml of Nitric acid was added. (Because the plant tissue contains a lot of organic matters and very high pressure will build up in the vessel during the microwave digestion process, the lined vessel should be used). The digestion program was then run by using microwave. After the pressure in the vessels was released over night, the digestion solutions were transferred into new plastic bottles and the total volume was brought to 50ml with deionized water. The chemical analyses were performed on a Siemens SRS 200 X-ray Fluorescence (XRF). To verify the result, a Perkin-Elmer Optima 3000 Inductively Coupled Plasma (ICP) equipped with a Spectro Sonic Nebulizer was also used.

RESULTS AND DISCUSSION

The ICP and X-Ray Fluorescence results for the lead concentrations in soil match very well. As shown by figure 1 and figure 2, the soil samples from Magazine Street had the highest lead concentrations for both ICP and X-Ray Fluorescence tests. The soil samples from St. Charles street showed second highest lead concentrations. Although Magazine street and St. Charles street are both the busiest streets in New Orleans, the lead concentration of Magazine Street soil is about four times higher. It is probably because of the different structure and texture of the soils. The St. Charles Street soil is very sandy and contains less organic matter. It should have less capacity to hold lead in the soil. The rural area showed the least lead concentration.

Various plant samples from rural area in Mandeville and high vehicular traffic area around Audubon Zoo were obtained for X-Ray Fluorescence experiment. Among the plant samples, the grass from Magazine Street showed the highest lead concentration (Figure 3, 4). The lead concentrations in Nandina, Grass, Ginger and Wax Myrtle were compared for high vehicular traffic area and rural area in Mandeville. The three plant samples taken from rural area in Mandeville were lower in lead concentrations than the samples from urban area. (Figure 3, 4) .

Although United States has discontinued the lead usage in gasoline for 20 years, the lead concentration in soil and plants in heavy vehicular traffic area is still much higher than in rural area. Since lead can be circulated into the upper troposphere and transported thousands of kilometers as the residence time of lead in the atmosphere ranges between 7 and 14 days (Shirahata et al 1980) and a lot of developing countries still use lead-contained gasoline as fuel in auto-industry, lead pollution will be a very long-term environmental problem that we have to solve.

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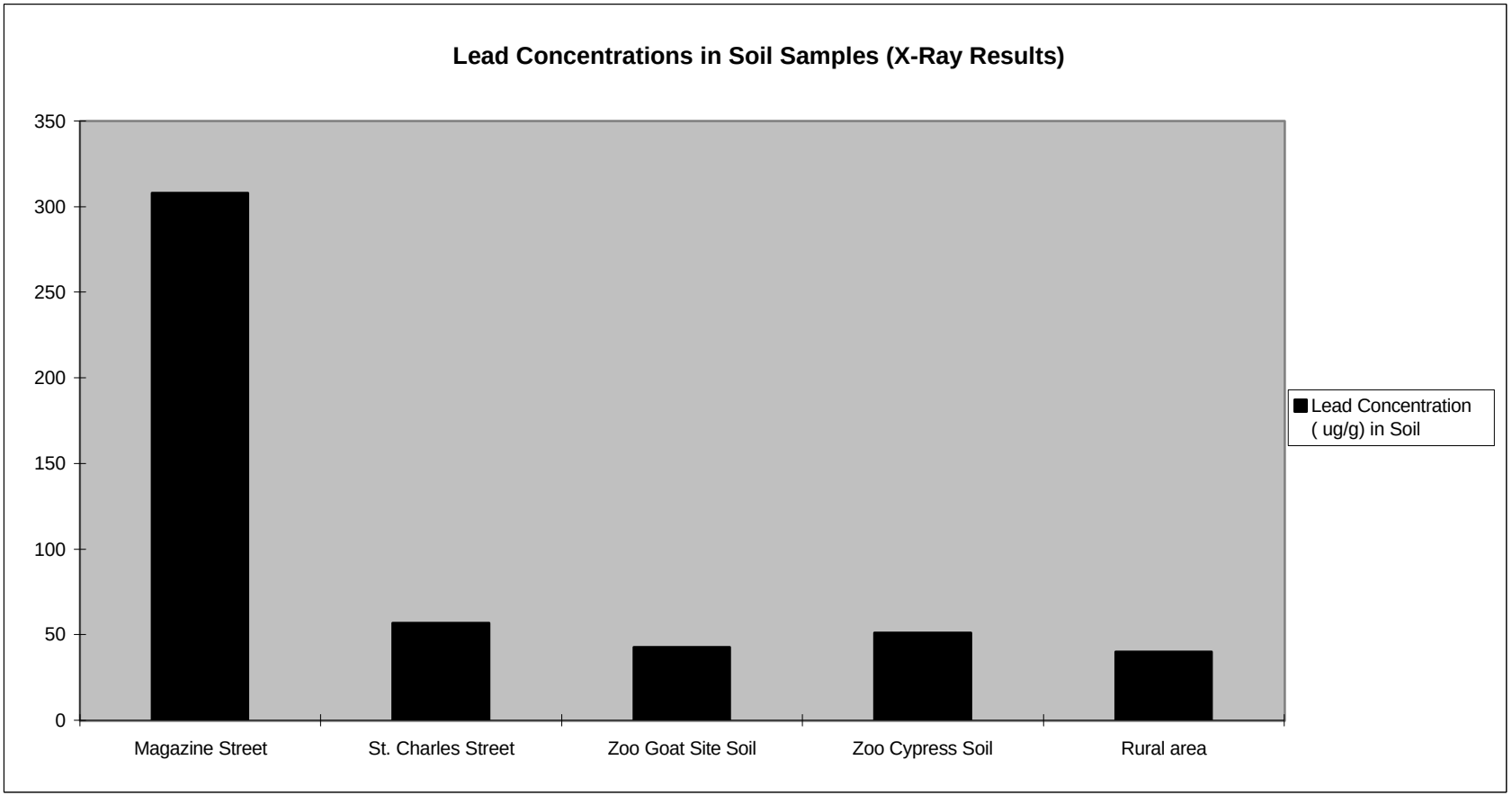

Figure 1. Lead concentrations in soil samples from X-Ray results.

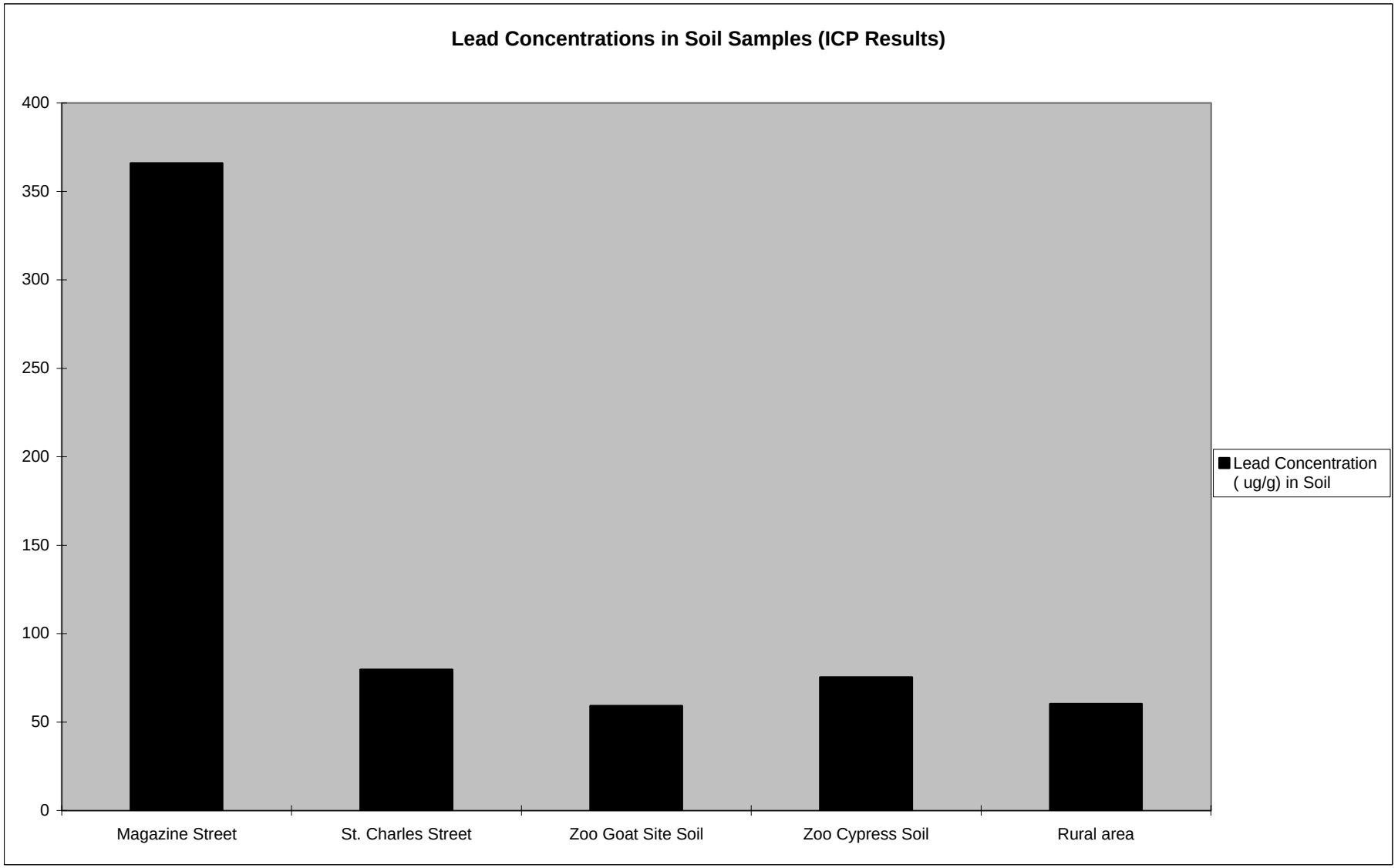

Figure 2. Lead concentrations in soil samples (ICP results)

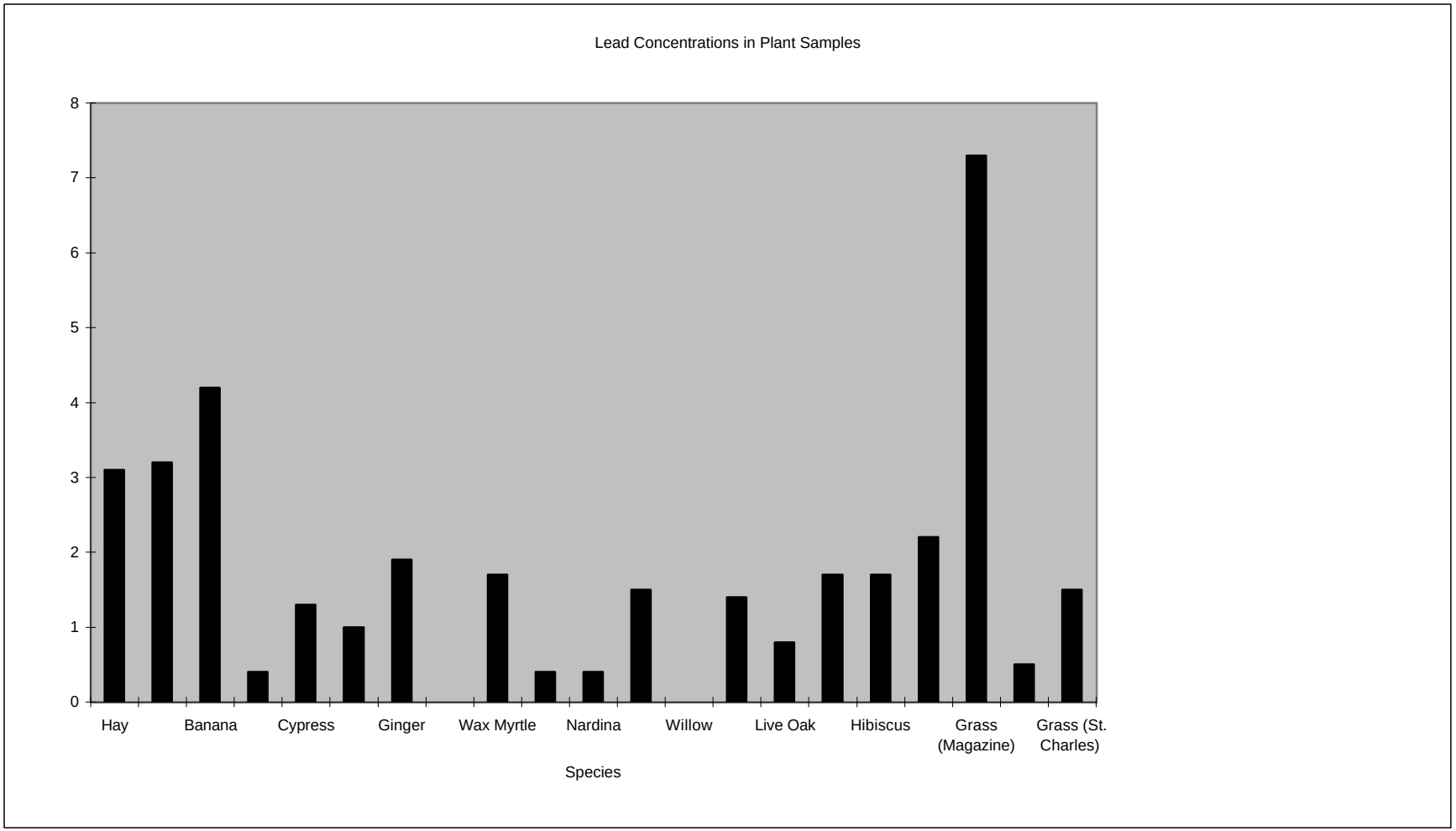

Figure 3. Lead concentrations (ug/g) in plant samples (X-Ray results). *Samples not labelled are from zoo.

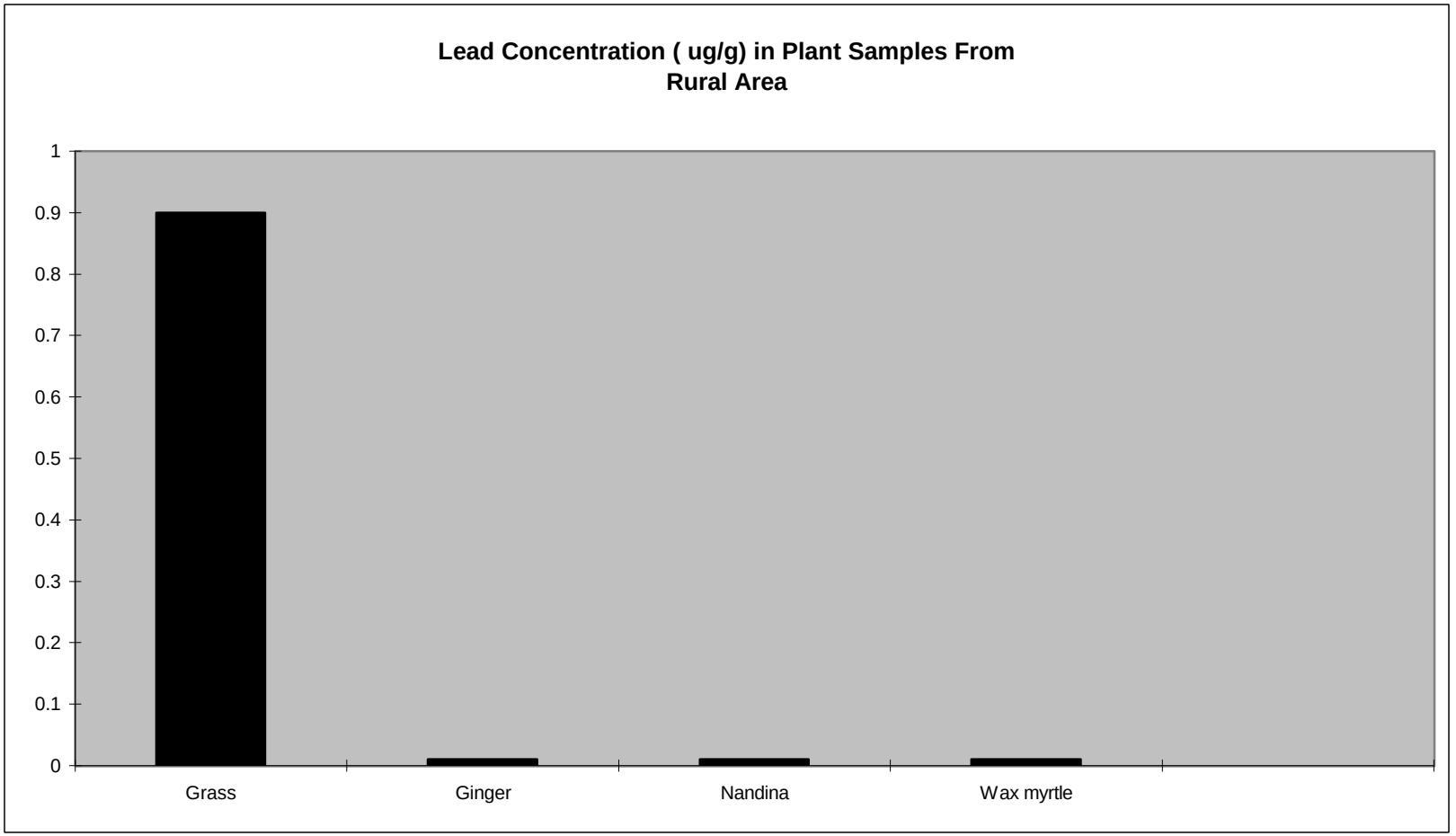

Figure 4. Lead concentrations in plant samples from rural area.